#1823

ELECTRONIC INSTRUMENTS

#1823

MICRO-PULSER

INSTRUCTION MANUAL

#1823

KAY ELECTRIC COMPANY

14 Maple Ave., Pine Brook, N. J.

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THE MICRO-PULSER

FUNCTION: The function of the Micro-Pulser is to produce rectangular pulses of 0.5 to 5 microseconds duration, having an amplitude of 0 to ± 50 volts, at a repetition rate of 200 to 20,000 pps. Both the rise time and the fall time of the output pulse is under 0.15 microseconds. The Micro-Pulser generates simultaneous positive and negative synchronizing pulses, for use in external equipment, which precede the output pulse by an interval adjustable between 10 and 1000 microseconds. This feature is of particular value because it makes it possible to start an associated oscilloscope sweep before the Micro-Pulser output pulse so that circuit response can be studied on a high speed sweep without losing the first several microseconds. In addition, the Micro-Pulser can be synchronized with an external generator of sine waves or pulses of either polarity.

OPERATION: Operation of the Micro-Pulser as a synchronizer for Radar, Television, Pulse Time Modulation, or similar equipment, or as a test signal source for pulse response studies, is quite straightforward. The manner of adjustment of all dials but one is evident from the labeling and the output time plot on the front panel of the Micro-Pulser: "T1" fixes the delay between (input and/or output) sync pulse and Output Pulse, "T2" fixes the remainder of the natural period of V2 (which is the actual operating period when there is no sync input), the switch with positions "X1" and "X10" fixes the factor by which both "T1" and "T2" dial readings must be multiplied, "Pulse Duration" fixes the duration of the Output pulse but has no influence on the output Sync pulse duration, "Output Volts" controls Output Pulse amplitude, and the switch having positions "+" and "-" controls Output Pulse polarity.

The process of adjustment of "Sync Adj." to synchronize the Micro-Pulser with an external sync signal generator is quite straight forward. Dial "T2" is adjusted so that with the settings of "T1" and the "X1 - X10" dial fixed for desired pulse delay, "T1" plus "T2" multiplied by the setting of the "X1 - X10" dial is about half again as great as the period of the input sync signal. If the sync signal is a pulse having a fairly sharp leading edge and an amplitude of 5 peak volts or more, the "Input Sync Polarity" switch is set to the proper position and "Sync Adj." is set to the clockwise stop. If it is desired to synchronize the Micro-Pulser from an external signal of a different shape, or if it is desired to operate the Micro-Pulser at a sub-multiple of the sync input repetition rate, there will be an optimum setting of both "T2" and "Sync Adj." dials. One method of checking adjustment for synchronization is to utilize the sync input pulse to synchronize both the Micro-Pulser and the sweep of an oscilloscope. The sync input pulse should likewise be connected directly to the "Bottom" deflecting plate of the oscilloscope and the sweep rate should be adjusted to show several cycles of the input sync voltage wave. The Output Pulse of the Micro-Pulser is then connected to the "Top" deflecting plate of the oscilloscope and the "Output Volts" and "Pulse Duration" controls are set for maximum pulse amplitude and duration. The oscilloscope is then observed as the controls "T2" and

"Sync Adj." are adjusted for the desired condition of synchronization. When the proper settings are obtained, the connections to the oscilloscope can be removed and the desired test can be carried out.

CIRCUIT DESCRIPTION: The Micro-Pulser consists of a four tube pulsing circuit chassis plus an auxiliary power supply chassis containing a rectifier tube and appropriate filter circuits. Both chassis are housed in a single crackle finish cabinet in an arrangement designed for maximum accessibility to tubes for replacement. Considerable attention has been paid to the problem of layout for shortest possible lead length in signal carrying circuits. A unique mechanical design has overcome the difficulties of connecting signal circuits from the vacuum tubes to the several input and output jacks and to the controls that are necessarily located on the panel.

The pulsing circuit chassis contains three type 6SN7 GT twin triodes and a single type 6AG7 television pentode. (In the subsequent discussion, the triode units of twin triode tubes will be referred to as section A and section B, where section A is the triode connected to tube socket terminal 1, 2, and 3 and section B is the triode connected to terminals 4, 5, and 6.) Referring to the Micro-Pulser schematic section B of tube V1 is the Input Sync Amplifier whose function is to amplify and isolate externally generated synchronizing pulses or sine waves. The output of V1B is connected through mica condenser C5 and Input Sync Polarity Switch S1 to tube V2, the Pulse Delay and Pulse Rate Multivibrator. The circuit of V2 nas been designed to produce a mulivibrator capable of operation over a wide range of repetition rates and duty cycle (ratio of conduction time of one tube section to conduction time of the other section) without instability or sensitivity of time intervals to tube variations.

In order to describe the operation of V2 in producing the desired pulse delay and pulse rate we shall assume that a negative pulse is connected to the sync input terminals and R6 is set at the CW stop. Tube V1B will amplify and invert the input to produce a positive pulse at its plate. With switch S1 set for a negative input pulse, the plate of V1B is couple to the plate of V2B. With Time Multiplier Switch S2 and potentiometers R11 and R16 set so that the natural period of oscillation of V2 is greater than the period of the input pulse, the plate of V2B will start its upswing at the instant of the leading edge of the sync input pulse. If S2 is set at X10 (for instance) the upswing at the plate of V2B is coupled through C6 to the grid of V2A so that the grid is driven up from below plate current cut off into the region of plate current conduction. The flow of plate current in V2A produces a drop in potential of V2A plate which is coupled through condenser C8 to V2B grid. The drop in potential of the grid of V2B causes a decrease in the plate current of V2B which produces an additional rise in V2B plate potential. Since this change in potential of V2B plate is in the same direction as the initial impulse impressed thereon by V1B, the initial pulse is reinforced and V2A is accordingly driven into heavy plate current conduction while V2B grid is driven far below plate current cut off. Section V2A is capable of remaining stably in this condition of heavy conduction, since

even after the flow of V2A grid current through C6 and R14 has charged C6 fully, the grid is still held positive by virtue of the return of the R11 - R12 grid resistor combination to the positive potential produced at the junction of voltage divider resistors R9 - R10 section V2B, however, will remain cut off only as long as it takes C8 to discharge (S2 being still in the X10 position) through R15, R16, and the combination of R17 and R18. Since the negative pulse at the plate of V2A is about 100 volts, the multivibrator "flop-over" initiated by the sync input pulse causes the grid of V2B to be driven down from a previous positive potential of about 1 volt to a negative potential of about 100 volts. The grid potential of V2B then rises exponentially as C8 discharges toward an ultimate potential of + 100 volts fixed by the voltage divider R17 - R18 to which the discharging resistors R15 - R16 are returned. In the course of a time interval equal to about 51% of the time constant -- C8 x (R13 + R15 + R16 + R17 + R18/R17 x R18) the grid of V2B will rise to -20 volts with respect to ground at which point V2B will begin to pass plate current. When V2B begins to pass plate current, V2B plate potential will drop, driving V2A grid in the negative direction, thereby initiating a second "flop-over" which ends with V2A cut off and V2B conducting heavily. Section V2A will then remain cut off until C6 discharges sufficiently to bring V2A grid to -20 volts, or until a second sync pulse is produced by V1B, whichever occurs first. With the proper adjustments the second input sync pulse will occur first, terminating the first complete cycle of V2 and initiating an identical second cycle. The natural period of multivibrator V2 is set by potentiometers R11 and R16 and switch S2. With switch S2 set at X1 the coupling capacitance between V2A plate and V2B grid is that of C8 and C9 in series, or about 82 MMF, so that adjustment of R16 brings about a variation in "off-time" of V2B between the limits of 10 and 100 microseconds. The effective capacitance between V2B plate and V2A grid is that of C6 and C7 in series, or about 91 MMF, so that adjustment of R11 causes a variation in "off-time" of V2A between the limits of 40 and 400 microseconds. Similarly when switch S2 is in the X10 position, C7 and C9 are shunted out and all time intervals in tube V2 become ten times as great. Note that the Micro-Pulser operates equally well with or without an input sync pulse.

Up to this point, we have considered the operation of Input Sync Amplifier V1B and Pulse Delay and Pulse rate Multivibrator V2 in producing oscillation of V2 over a wide range of pulse rates and duty cycle. We will next describe the operation of V2 in driving V1A to produce positive and negative sync output pulses and in triggering V3 to produce rectangular pulses delayed with respect to the output sync pulses. Section A of V1 is quiescently biased in the positive grid region by virtue of the return of grid resistor R4 to the plate supply voltage. Therefore, when differentiating circuit C4 - R4 produces a positive pip at V1A grid at the instant that V2A plate potential rises, no appreciable change in V1A plate current occurs and no output pulse is produced. On the other hand, when V2A plate potential drops, a negative pulse is produced at the cathode and a positive pulse at the plate of V1. These two pulses are coupled through condensers C2 and C3 to the terminals of the Sync Output Jack so that both positive and negative output sync pulses are available at the same time. When both a sync output pulse and a sync input pulse are used, the sync output

will be in exact time phase with the input.

Tube V3 is a pulse generator having section A quiescently conducting heavily by virtue of the positive grid bias of about 10 volts imposed by resistors R19 and R20 and having section B quiescently cut off by virtue of the positive cathode bias produced by resistors R23, R24, and R27. When the plate potential of V2B drops, a negative pip is produced at V3A grid by differentiating circuit C10 - R19 - R20. This pip initiates a "flop-over" in V3 which ends with section B conducting heavily and section A cut off. Section B can be held indefinitely in the heavy conduction condition by flow of several milliamperes of grid current through L1, R21 and R22, but section A remains cut off only for the short interval needed for the condenser selected by Pulse Duration Switch S3 to discharge partially through R and the parallel combination of R19 and R20. When the discharge of the condenser selected by S3 brings V3A grid up to -20 volts, plate current conduction begins and a second "flop-over" occurs, returning the tube to the quiescent condition. During the conduction interval of V3B, a positive pulse is produced across Output Volts Potentiometer R23 in the cathode circuit. A fraction of this voltage pulse fixed by the setting of R23 is coupled to Output Amplifier tube V4 which accordingly produces a positive cathode pulse and negative plate pulse, both at low impedance level. Output Pulse Polarity switch S4 selects either the positive or the negative pulse which is then coupled through C19 to the Pulse Output Jack. Although tube V3 was triggered by a negative pip just as was V1A, the negative plate swing at V2B (which triggers V3A) always follows the negative plate swing a V2A (which triggers V1A) by a delay fixed by "Time Multiplier" switch S2 and "T1 Adjust" potentiometer R16. The Output Pulse produced by V4 therefore follows the Output Sync Pulse by a controllable delay and it has a controllable duration, polarity, amplitude, and repetition rate.

PARTS LIST

MICRO-PULSER

Tubes

V1	6SN7
V2	6SN7
V3	6SN7
V4	6AG7
V5	5U4

Resistors

R1	2700	ohms *	
R2	2700	"	
R3	22000	"	1 watt
R4	560000	"	
R5	22000	"	2 watt
R6	100000	"	Pot. SYNC. ADJ.
R7	15000	"	1 watt
R8	1500	"	1 watt
R9	120000	"	1 watt
R10	47000	"	
R11	5 meg	"	Pot. T2
R12	560000	"	
R13	4700	"	2 watt
R14	10000	"	10 watt
R15	220000	"	1 watt
R16	2 meg	"	Pot. T1
R17	47000	"	
R18	120000	"	1 watt
R19	91000	"	2 watt
R20	91000	"	2 watt
R21	10000	"	10 watt
R22	10000	"	
R23	2000	"	Pot. PULSE AMP.
R24	3900	"	
R25	27000	"	
R26	560000	"	
R27	27000	"	2 watt
R28	100	"	
R29	390	"	1 watt
R30	100	"	
R31	560000	"	
R32	300	"	1 watt
R33	1000	"	
R34	8200	"	
R35	2700	"	1 watt

* All resistors $\frac{1}{2}$ watt unless otherwise specified

Condensers

C1	10000 mmf	300 v	Mica
C2	10000 mmf	"	"
C3	10000 mmf	"	"
C4	10 mmf	500 v	Ceramicon
C5	33 mmf	"	"
C6	1000 mmf	"	"
C7	91 mmf	"	Mica
C8	800 mmf	"	"
C9	91 mmf	"	"
C10	10 mmf	"	Ceramicon
C11	550 mmf	"	Mica
C12	193 mmf	"	"
C13	60 mmf	"	Ceramicon
C14	25 mmf	"	"
C15	0.25 mf	400 v	Paper
C16	20 mmf	500 v	Ceramicon
C17	10000 mmf	300 v	Mica
C18	25 mf	25 v	Electrolytic
C19	1 mf	400 v	Paper
C20	40 mf	450 v	Electrolytic
C21	40 mf	"	"
C22	10000 mmf	300 v	Mica

Transformers

T1	Power transformer	Thordarson T22R07

Coils

L1	1 millihenry
L2	10 henry, 75 ma.

Connectors

J1	General Radio	SYNC. INPUT
J2	" "	SYNC. OUTPUT
J3	" "	PULSE OUTPUT

Switches

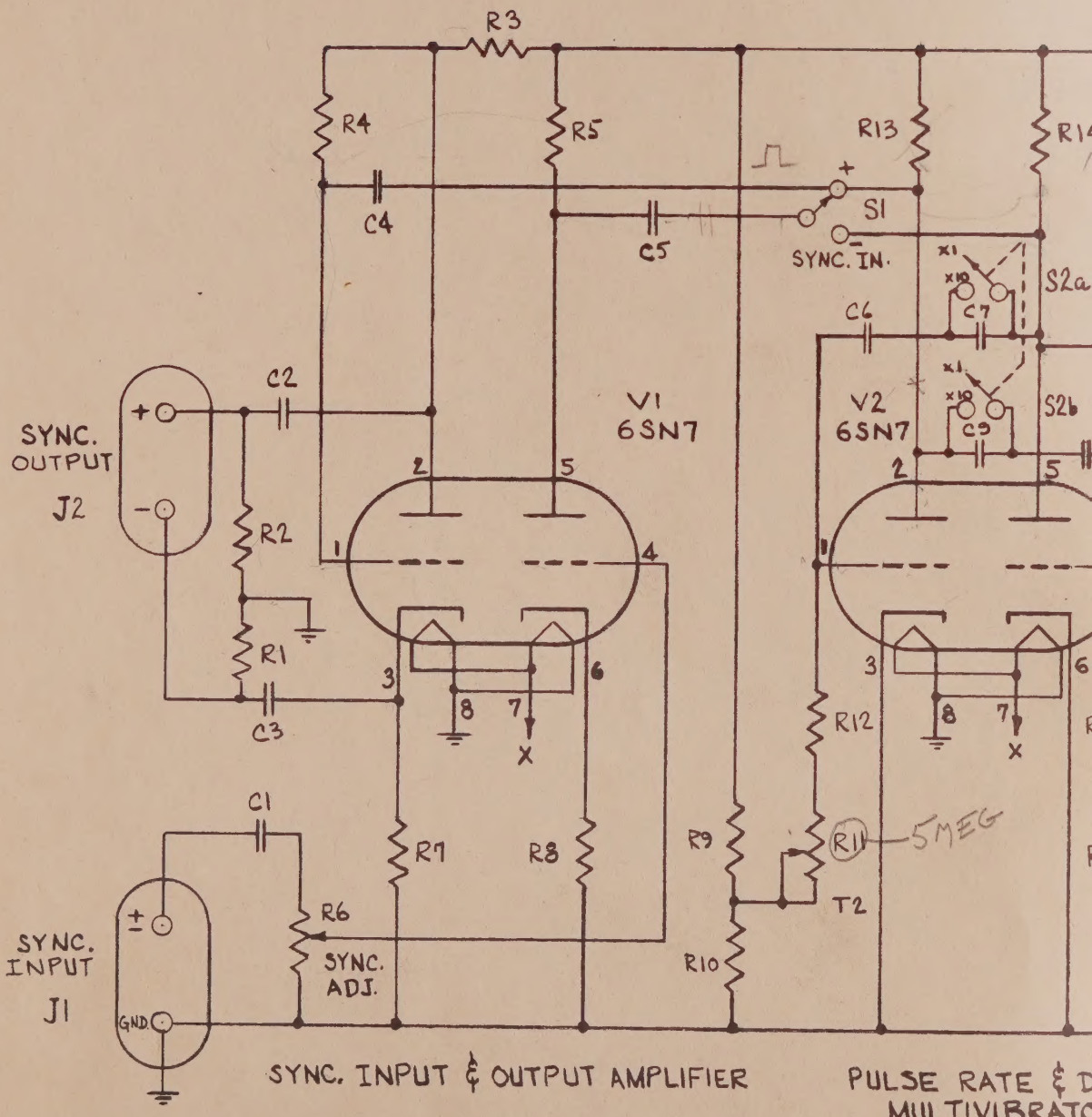
S1	S.P.D.T.	SYNC. INPUT
S2a,b	D.P.D.T.	x 1, x 10
S3	4 Pos. Rotary	PULSE WIDTH
S4	S.P.D.T.	Output Polarity
S5	S.P.S.T.	ON-OFF

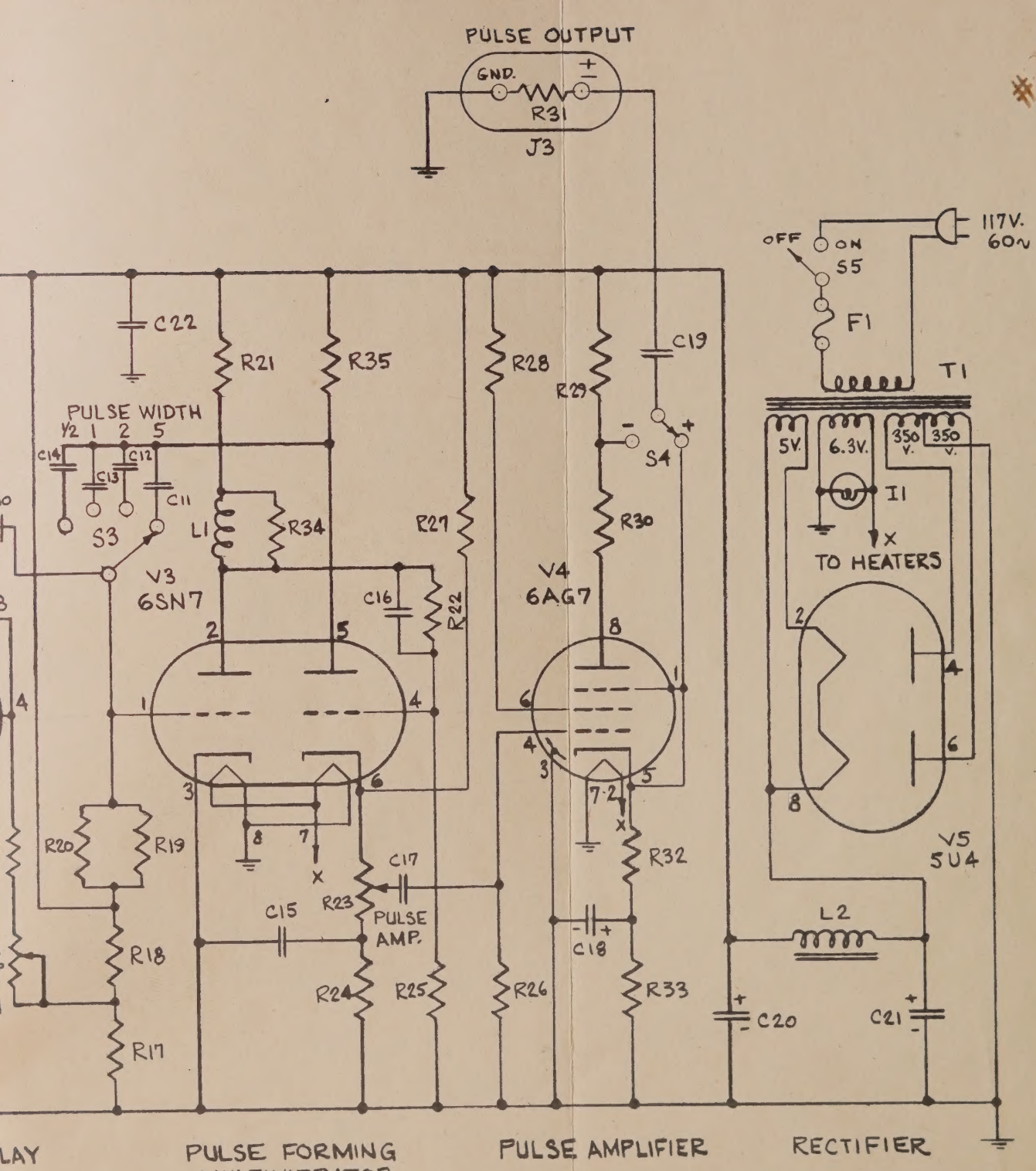
Fuse

F1	3 amp.

Pilot Lamp

I1	#47	Bayonet type


R3
R4
R5
R13
R14
C4
C5
S1
SYNC. IN.
x1
x10
C7
S2a
C6
C2
V1
6SN7
V2
6SN7
C9
S2b
SYNC.
OUTPUT
J2
R2
R1
C3
1
2
3
4
5
6
7
8
X
C1
R7
R8
R9
R11
5MEG
T2
R12
R10
R6
SYNC.
ADJ.
SYNC.
INPUT
J1
GND
SYNC. INPUT & OUTPUT AMPLIFIER
PULSE RATE &
MULTIVIBRATO



MICRO-PULSER

SCHEMATIC

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